

## Plenary 5: Body Weight Regulation

### High protein meals and diets in appetite and body weight regulation

MS Westerterp-Plantenga

Department of Human Biology and Nutrim, Maastricht University, P O Box 616, 6200 MD, Maastricht, The Netherlands & TIFN, Wageningen, The Netherlands

**Background** – Obesity is a major health problem with serious comorbidities. Conditions for weight maintenance after weight loss are (i) sustained satiety despite negative energy balance, (ii) sustained basal energy expenditure despite body-weight loss due to (iii) sparing of fat-free mass, being the main determinant of basal energy-expenditure.

Relatively high-protein diets have been shown to act on these metabolic targets.

**Objective** – This presentation focuses on satiety, taking type and quantity of protein, administration of protein, timing of effects, characterization of subjects, energy balance, duration of studies, and adverse events into account.

**Design** – Assessing possible differences between satiating efficacy of high specific protein-meals or –diets is executed using a realistic band-width of energy intake and protein concentrations of 20% to 30% of energy from protein in energy balance. Identification of timing of effects is essential, therefore synchronization with amino acid profiles, VAS ratings or ghrelin concentrations is applied. Assessment of mechanisms encompasses assessment of concentration changes of (an)orexigenic hormones, amino-acid profiles, and energy expenditure. Coincidence of differences in short-term satiety with increased amino-acid concentrations, and concentrations of ‘anorexigenic’ hormones are determined, in order to underscore nutrient-induced satiety. Relationship of medium-term elevated protein induced satiety and elevated energy expenditure is determined. Related macronutrient balances are determined as well.

**Outcomes** – The satiating effect of protein is the key-player in body-weight loss and body-weight maintenance thereafter. Specific high-protein-meals or –diets induced satiety require a realistic band-width of energy intake, protein concentrations, texture, and timing of assessment of effects. Satiety is nutrient specifically supported by elevated amino acid concentrations, responses of anorexigenic hormones or protein-induced energy expenditure.

Highly-controlled medium term studies overcome possible differences due to solid, semi-solid or liquid food, timing and macronutrient exchange, and imply the possibility to assess satiety, energy expenditure and substrate oxidation at the same time. This still needs to be executed with different types of proteins in overweight subjects in different energy balances.

Relatively larger body weight loss on a sustained relatively high protein diet relates to high-protein-diet induced satiety, energy expenditure, and sparing fat-free mass. Since under iso-energetic conditions no statistically significant difference between body weight loss on a high-protein vs high-carbohydrate diet appeared although body composition did improve, *ad libitum* energy intake conditions are necessary in order to lose more body-mass.

Relatively high-protein diets consumed *ad lib* also promote weight maintenance. For example, overweight to moderately obese men and women who had lost  $7.5 \pm 2.0\%$  body weight over 4 weeks and consumed 18% of energy intake as protein, regained less weight (1 kg) after 3 months, compared to those consuming 15% of energy as protein (weight regain 2 kg), or of 0.8 kg vs. 3.0 kg after six months, or 1.0 kg vs. 3.9 kg after 1 yr. Here evidence shows that a relatively high protein intake sustains weight maintenance by (i) favoring regain of fat free mass at the cost of fat mass at a similar physical activity level thereby sustaining energy expenditure, (ii) reducing the energy efficiency with respect to the body mass regained, and (iii) increasing satiety. For effects due to satiety *ad libitum* energy intake conditions are necessary. Adverse events related to kidney damage may occur with sulphur-containing amino acids; subjects with obesity, metabolic syndrome and diabetes mellitus II may be susceptible groups.

**Conclusions** – Protein-induced satiety after high protein meals is nutrient specifically supported by elevated amino acid concentrations, responses of anorexigenic hormones or protein-induced energy expenditure.

Relative high-protein low-energy diets, offered *ad lib*, whereby the absolute amount of protein as consumed before dieting is sustained, promote weight loss as well as weight maintenance. It remains to be assessed whether and how different types of protein contribute differently to this phenomenon.

#### References

1. Soenen S and Westerterp-Planenga MS. Proteins and satiety: implications for weight management. Current Opinion in Clinical Nutrition and Metabolic Carem, 2008, in press.